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Holding Live Lobsters in Aerated Artificial Sea Water

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During recent years the handling and transportation of live lobsters have improved to such an extent that successful shipments across the continent are now made regularly. This development has opened up extensive inland markets for live lobsters. Unfortunately, the development of inland holding facilities has not kept pace and the difficulties associated with holding live lobsters hundreds of miles from the sea have hindered marketing.

At present lobsters are usually stored in air in iced containers. Under these conditions lobsters will survive for a few days but are usually sluggish in appearance and not attractive for display purposes. If the holding period is extended the lobsters tend to weaken and heavy mortalities frequently occur. Holding units made of glass and stainless steel, equipped with mechanical refrigeration and filtration, have been developed elsewhere and are gradually being adopted by the trade. These, however, tend to be expensive and although excellent for display purposes are more elaborate than necessary for simply maintaining a supply of live lobsters.

Since the summer of 1949 many experiments have been carried out on the factors, such as temperature, salinity and oxygen, which control the survival of lobsters in both natural and artificial sea water. This circular summarizes our present knowledge of the conditions required for the successful holding of live lobsters. A simple, inexpensive wooden holding unit is described in which commercial quantities of lobsters have been kept alive and active for several weeks.

Temperature

In nature lobsters thrive under a wide range of temperatures, the water sometimes dropping to 30 degrees Fahrenheit (30° F.) during winter and often, particularly in the shallow areas, exceeding 70° F. in the summer. When all other conditions are good, lobsters accustomed to warm water can live at almost 90° F. for several days at least. Although lobsters are remarkable in their ability to adjust themselves to changes in temperature, extreme sudden changes should be avoided as much as possible.

Even though lobsters can withstand high temperatures, experience has shown that when held under crowded conditions they survive best at low temperatures of about 35 to 40° F. At this temperature, however, lobsters are sluggish and not very satisfactory for display purposes. Considering survival, the activity of the lobsters and refrigeration costs, 50° F. is suggested as a reasonable compromise.

Where lobsters are not intended for display a temperature of 50° F. or lower is readily obtained by placing the holding unit in a controlled-temperature cool room such as those used for storing unfrozen meat. If this has a temperature so low that the lobsters are sluggish, the water can be warmed with a stainless steel immersion heater or with partially immersed light bulbs of the required wattage. If such a cool room is not available, reasonably satisfactory temperatures can be obtained during the cooler months in an unheated section of a basement. If ice is used in warmer weather to cool the water it must not be put in the tank itself as this would make the water fresher and perhaps kill the lobsters.

If public display at ordinary room temperature is of primary importance a mechanical refrigeration unit is necessary.

Natural and artificial sea water

Natural sea water is a solution containing a great variety of dissolved salts. In the open ocean the salt content is usually about 3½% by weight but along the coast, where lobsters are caught commercially, freshwater run-off reduces the salt content to about 3%. If other conditions are favourable lobsters can live in sea water containing as little as 2½% salt or as much as 4½%.

On the coast live lobsters are usually held in floating crates, larger wooden "cars", in dammed-off coves, or in wooden tanks which are continuously supplied with running sea water.

For holding at points within reasonable shipping distance of the coast it would probably be cheaper and more convenient to use natural than artificial sea water.

A Simple Inexpensiv

The simple inexpensive holding unit in which lobsters have been held successfully for three to seven weeks is shown in the accompanying diagram. It would be satisfactory for commercial use where display is not important.

WOODEN TANK —— The watertight tank 4' x 4' x 8" inside dimensions was made of 1¾" seasoned, dressed pine, caulked with cotton. At the ends of the bottom planks the side planking was run vertically to permit uniform swelling. Two ½" threaded iron bars across opposite sides and one across the centre were provided to tighten the tank if shrinkage occurred. To avoid possible toxic effects no paint was used. Five holes, one in the centre and one about a foot out from each corner, were drilled through the floor of the tank for the air lines. In use the tank was filled to a depth of 6 inches with 50 imperial gallons of artificial sea water. When dry the tank alone weighs about 150 pounds and since it will hold over 500 pounds of water it must, if raised to a convenient working height, be provided with a strong base.

This description is intended only as a guide. Different tank dimensions may be more suitable for particular situations. It is best, however, to avoid large tanks in which lobsters tend to "bank" in the corners and suffocate. Culling is difficult in wide, deep tanks.

AERATION —— A small, service-station type of air compressor equipped with a ½-horse-power motor and a 25-gallon tank provided enough compressed air to operate several holding units. Where the power supply is unreliable a larger storage tank would be desirable to provide a greater air reserve in case of power failures. The compressor was equipped with a reducing valve to supply air to the tanks at about 10 to 20 pounds pressure. In areas with a reliable source of power, continuous operation of a smaller, less expensive compressor without a storage tank should be perfectly satisfactory. If the air supply is off for more than a few minutes the lobsters should be removed and held in air until the water is properly aerated again.

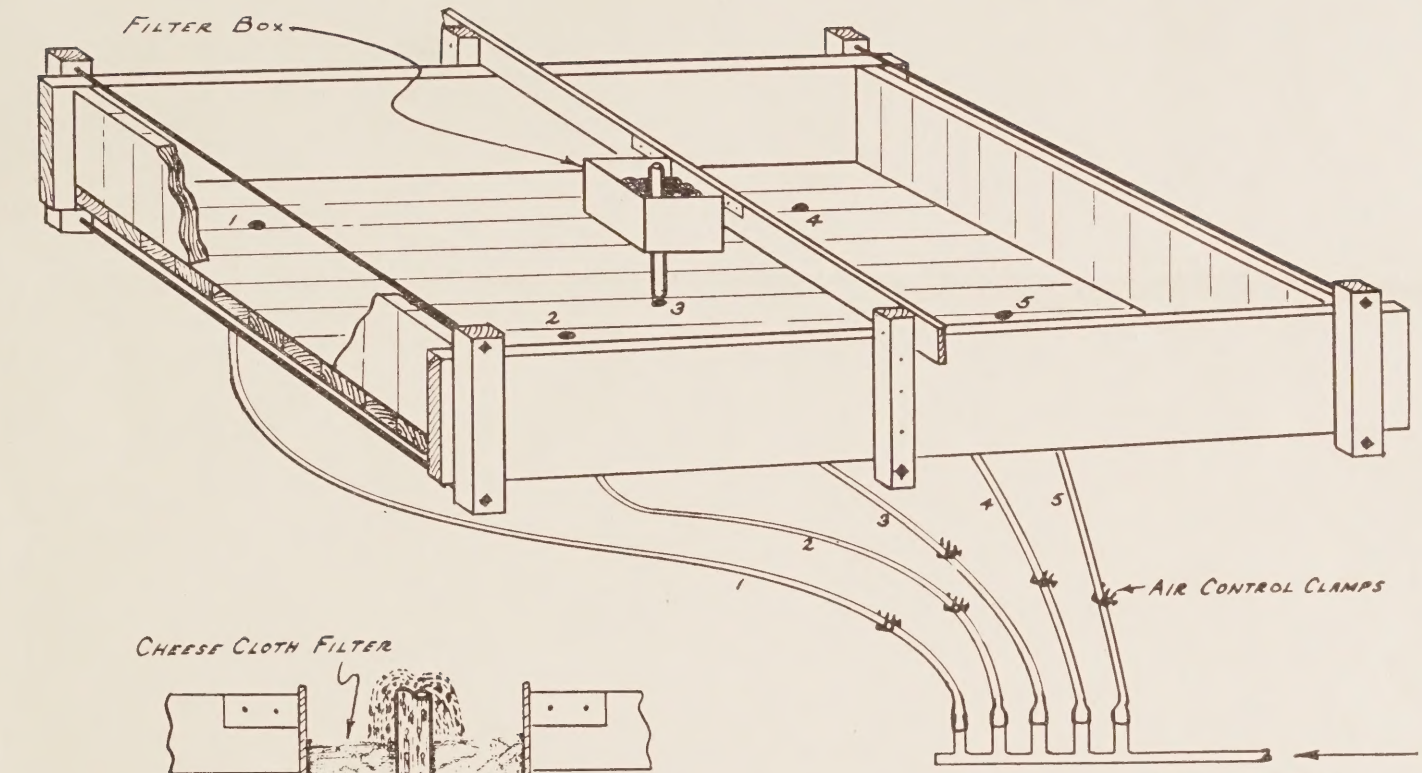
The main air line from the compressor was of galvanized pipe and rubber hose and was divided into five smaller lines, each going through the floor of the tank to an air stone. These lines of flexible rubber tubing were provided with adjustable clamps to control the amount of air bubbled through each stone.

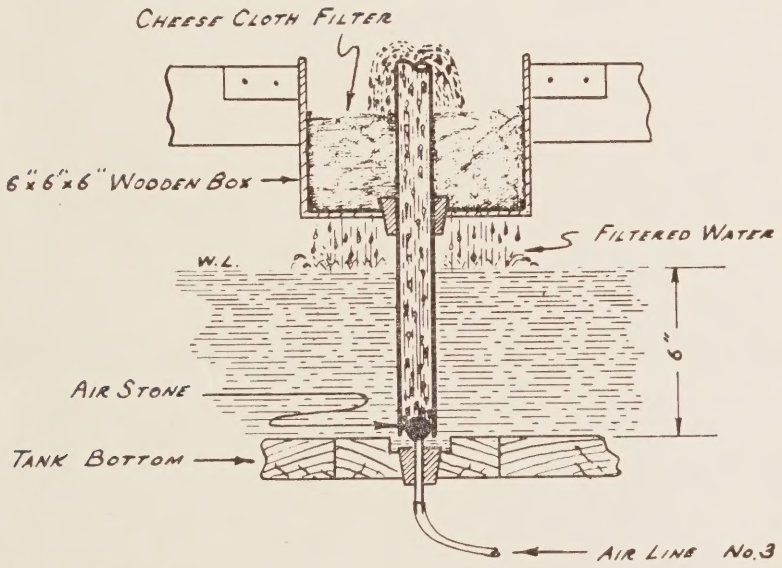
The 1" diameter, spherical air stones come equipped with hose connections which are easily connected to the rubber air lines. The five stones were partly recessed in the floor of the tank to reduce the danger of them becoming disconnected during holding operations. Air was bubbled through each of the corner stones at the rate of about 75 cubic inches a minute, enough to produce a gentle "boiling" at the surface directly above the air stone. The centre air stone which operated the filter required about 400 cubic inches of air a minute.

FILTRATION —— The 6" x 6" x 6" wooden filter box was placed just above the surface over the centre air stone, and filled to a depth of 3 to 4 inches with 5 yards of 40" cotton gauze or cheesecloth or with 3 ounces of good quality cotton waste. Numerous ¼" holes were drilled through the bottom of the box to drain off the filtered water. A 10½" piece of 1¼" inside diameter hard rubber tubing open at both ends was fitted over the air stone, about ½" from the floor of the tank, and up through the bottom of the filter box. Water forced up through this tube by compressed air drains back to the tank through the cotton filter. By adjusting the air flow and raising or lowering the rubber pipe slightly a steady flow of about 20 gallons per hour can be obtained. Cotton waste is cheaper and lasts longer than cotton gauze but is not quite so convenient to handle.

COSTS —— The major capital expenditure for such a holding unit is the air compressor. Depending on the type and size selected the cost could vary from seventy-five to several hundred dollars. The larger compressor will, of course, operate several holding units. The wooden tank should not cost over twenty-five dollars for material and labour. Air stones, air lines and clamps for one holding unit should cost no more than twenty-five dollars. The quantity of technical grade salts required for 50 imperial gallons can be obtained for about one dollar if purchased in standard quantities. The purer grades of salt are considerably more expensive. The water should be renewed at least every three weeks. The cotton filter material varies considerably in price depending on quality but the cost of maintaining a filter should be less than $1 per week.

Holding Unit





FILTER BOX DETAIL

JAN. 53

Where the cost and inconvenience of transporting natural sea water prohibits its use, artificial sea water forms a good substitute. Several satisfactory formulae for artificial sea water are known but some call for a considerable number of different salts and for this reason are inconvenient to prepare. The following relatively simple formula developed by Schmalz for use in the Berlin marine aquarium is suitable for holding live lobsters. The five salts required are fairly common, inexpensive and generally available. They can usually be obtained in the better grades in convenient sized packages from wholesale drug houses. The considerably cheaper technical grades, which are just as satisfactory for holding lobsters, can be purchased through various chemical supply firms. The weight of each salt to be dissolved to make up 50 imperial gallons (60 U.S. gallons) of artificial sea water is as follows:

Sodium chloride (NaCl)	- 14 lb. 2 oz.
Magnesium sulphate ($MgSO_4 7H_2O$)	- 3 lb. 7½ oz.
Magnesium chloride ($MgCl_2 6H_2O$)	- 2 lb. 12 oz.
Calcium chloride ($CaCl_2 2H_2O$)	- 11½ oz.
Potassium chloride (KCl)	- 5½ oz.

The salts are simply added to 50 gallons of tap water and stirred occasionally until completely dissolved. This process will take several hours with cold water but can be speeded up considerably by heating a portion of the water. Some foreign materials usually present in the cheaper grades of salt may not dissolve but these do not interfere in any way.

Oxygen requirements

Sea water normally contains 1½ to 2 cubic inches of dissolved oxygen per gallon, ample to satisfy the lobster's requirements under natural conditions. When lobsters are held commercially they are more or less crowded and will suffocate if the oxygen supply is not replenished continuously. Where an ample supply of sea water is lacking the oxygen can be replenished by bubbling compressed air through the water. The air (21% oxygen) dissolves in the water more readily if it is broken up into small bubbles by passing it through air stones or air breakers. These porous air stones which resemble carborundum in appearance are available in a variety of shapes and sizes from aquarium dealers and laboratory supply companies.

Filtration

Although lobsters will live for several weeks in unfiltered water, waste products quickly dirty the water and make it impossible to see the lobsters. This condition is unsuitable for display purposes, makes culling difficult and shortens the successful holding period. To keep the water clear, filtration is necessary. A simple air-lift filter is illustrated in the accompanying diagram. Since it operates on compressed air and makes use of one of the air stones needed to oxygenate the water, very little additional equipment is required. Water forced above the surface drains back into the tank through a filter box containing cotton gauze or cotton waste. The cotton filter should be rinsed out daily and replaced when it starts to deteriorate. This system, which doubtless could be improved, filters over 500 gallons daily, sufficient to keep the water clear throughout the holding period. Although glass wool filters the water satisfactorily, its use cannot be recommended since the short glass fibres, which become dispersed through the tank, appear to injure the lobsters.

Toxic materials

When holding lobsters in a restricted volume of water special precautions must be taken to avoid contaminating the water with any toxic materials.

Lobsters are sensitive to low concentrations of chlorine and difficulties may arise if heavily chlorinated drinking water is used to make the artificial sea water. The chloride can, however, be reduced considerably by bubbling air through each new tankful of artificial sea water for several hours before introducing the lobsters.

Certain metals such as copper, monel metal, zinc and lead are toxic to lobsters in that order. A clean sheet of copper placed in a tank of lobsters will kill them within 18 hours. The sea water must not come in contact with any of these metals or any of the alloys containing a large proportion of copper (brass, bronze, etc.). If metal is needed in a holding unit stainless steel or aluminum alloy should be used wherever possible. Iron, although non-toxic, is usually considered unsatisfactory because of rust formation.

Feeding

In nature lobsters eat a variety of fish and shellfish. When held for periods up to several months, particularly in pounds, they are usually given a regular diet of herring or other fish readily available at low cost. For short-term holding in a limited volume of water it is best, however, to omit food since any that remains uneaten quickly pollutes the water. Lobsters have been kept alive and active for seven months without food and, although the meat yield became lower, the flavour was not seriously affected.

Quantity of lobsters and length of holding period

Fifty pounds of lobsters have been held satisfactorily for three to seven weeks in 50 gallons of aerated artificial sea water. In emergencies considerably larger quantities can be held in the same volume for a few days providing the air supply is increased. These heavier concentrations pollute the water more quickly and shorten the satisfactory holding period. When 75 pounds were held in 50 gallons the successful holding period was reduced to nine days.

When the lobsters become sluggish and weak the tank should be drained, cleaned and refilled with fresh artificial sea water. Usually the lobsters weaken gradually over a period of two or three days before heavy losses begin, thus providing ample warning that the water should be renewed. Lobsters that gradually weaken will normally revive quickly in newly prepared artificial sea water. If the water is renewed often enough there appears to be no limit to the holding period. One lobster held in artificial sea water for over a year fed actively throughout this period and appeared normal in all respects.